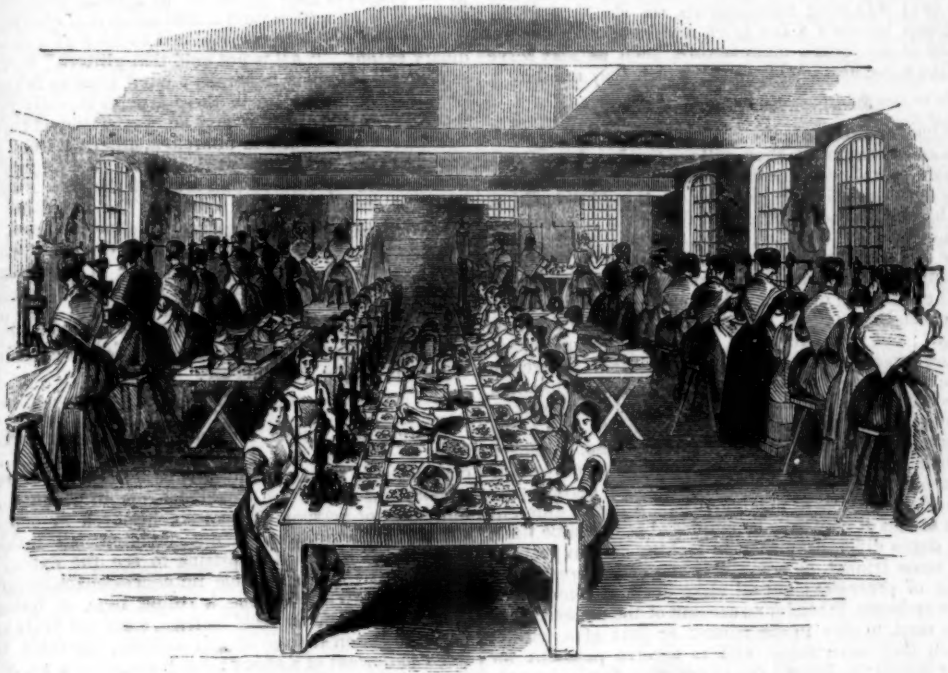
A DAY AT THE BIRMINGHAM FACTORIES.



[Stamping, Pressing, and Punching Buttons.—Elliott's Factory.]

It has been a sort of bye-word, that "Birmingham is the toy-shop of Europe." This phrase seems to have sprung up about the time when cheap gilt jewellery became extensively manufactured in that town; a species of goods which well merits admiration, when considered in reference to the skill whereby such economical produce has been rendered attainable; but which has to a certain extent acquired a bad odour from being palmed off, by itinerant hawkers and unscrupulous dealers, as solid gold productions, or at least as possessed of excellences which are really attainable only at a much higher price. But modify the phrase as we may, it goes but little way in characterising the manufactures of Birmingham; since (it may be safely affirmed) there is scarcely a house in the kingdom in which there is not, at almost every hour in the day, some useful article or other employed of Birmingham manufacture. The useful and the ornamental have progressed by parallel steps; and the general arrangements of the town have advanced with them both. Mr. Hawkes Smith, in his account of Birmingham, has alluded to the latter point in the following terms:—"The mode of conducting business in Birmingham has suffered a complete revolution since about 1760, at which period manufactures had multiplied and increased. Previously to that period, the 'Birmingham blacksmith' had been accustomed, from time immemorial, to keep his station at home, where he was visited by ironmongers and other dealers, who resorted to this town twice in the year from all parts of the country, to make their purchases. This was obviously, to the community at large, the most expensive as well as the least eligible mode of effecting the desired purpose; and as the variety of manufactures rapidly augmented, it became almost impossible for the customer to wait on the numerous fabricators. This led first to the employment of *agents*, who made purchases for the country traders, taking a commission for their trouble. These agents afterwards grew into a separate trade, becoming home-merchants, or *factors*, as they are termed. These factors travel through every part of the country, collecting orders, which they execute on their own account; carrying with them specimens of the different articles, if practicable; or pictured representations, where too bulky or too numerous. Their portable show-rooms were long enclosed within the swollen receptacles of a pair of leathern saddle-bags, which were slung across a horse, and on which the traveller, or rider (as he was then technically called), took his seat. But now a tolerably complete set of patterns will weigh 5 cwt., and, with their exhibitor, forms a full and ample load for a one-horse carriage."

The subdivision of trades at Birmingham is so apparently exhaustless, that to examine a small portion of them is all that a writer or a visitor can effect. There are very few large factories, properly so called, in which an article goes through the entire range of manufacturing processes; but there is a vast number of workshops, more or less extensive, in each of which portions of the work are done. One manufactured article, which is sold retail for a penny, may go through twenty workshops before it is finished; some having forty or fifty workmen, some four or five, while some are simply the garrets of workmen who ply their trade by their own fire-side. With the exception of the metropolis, there is perhaps no town in England where

there are so many persons combining in themselves the characters of master and workman, as Birmingham, and none in which there is more observable a chain of links connecting one with another.

The Supplement for October contained a general notice of the gold and silver plate manufacture, including the new art of electro-metallurgy. In this and the next following Supplements, we shall endeavour to group together a few brief notices of other departments of the town's manufacture, such as may serve to give some idea of the variety which they exhibit.

Small work in Gold and Silver.

Whoever looks into the glittering window of a jeweller's and silversmith's shop, will see to what class of articles we here allude. The interminable forms and appearance of the pencil-cases, pen-holders, thimbles, bodkins, toothpicks, tweezers, brooches, finger-rings, ear-rings, chains, bracelets, buckles, clasps, &c., point to the existence of a large and important subdivision of trades at Birmingham. Some of these small trinkets are made of solid gold, some of silver, while some have only a thin superficial coating of one or other of these precious metals; but in any or all of these cases, the manufacturing arrangements are pretty much alike. There are warehouses, the proprietors of which form a medium between the small manufacturers and the buyers. They give out their small ingots of silver, or a given weight of gold in sheets, to workmen who, employed at their own homes perhaps, or working three or four for some intermediate master, perform a certain portion of the process of manufacture. A dozen different men or sets of men may be employed at the same time, in a dozen different places, in making certain parts of the same trinket, or some may succeed others in the order of processes; but all alike come at intervals to the warehouse, to render an account of the material they have used, to give in the trinket or part of a trinket which they have made, and to receive payment for their labour; and there are, in every particular branch, persons whose business it is to put together the various pieces of which the article may be made.

A jewellery or trinket-factory, properly so called, is perhaps hardly to be found in Birmingham, since almost every workman, and almost every small master, confines his attention to some one subdivision of processes. But if we were to follow the articles through the various workshops, we should find that the processes of manufacture are generally manipulative, or very little dependent on machinery. For *pencil-cases*, and other articles having a barrelled or cylindrical form, the sheet metal (silver or whatever else it may be) is tube-drawn into shape, something in the same manner as wire; and, by punching, stamping, turning, soldering, and other mechanical processes, is worked up into the finished state. If the barrel be figured or ornamented, as is generally the case, the device is given by passing the sheet-metal between two steel rollers figured with a similar ornament, before being drawn into a tube. In the *ever-pointed pencils* there are many little bits of apparatus to be made separately, such as the tapering point, the wire pusher, the screw, the reserve cell, &c.; but all this is small bench-work, in which lathes, vices, hammers, files, draw-plates, soldering apparatus, &c. are used, on a scale which renders it essentially a handicraft employment. *Thimbles* are brought to shape principally by means of stamps or punching-presses, so arranged as to bend up thin sheets of metal into the required form. If we were to extend our range throughout the list of trinkets and cheap jewellery, we should find that, in respect to the actual manufacture, such tools as we have mentioned, and such work as a man could carry on in a small room, are in most cases adequate to the object in view, and involve a system remarkable rather for the minuteness of its subdivision than for its unity as a whole.

A large part of the ingenuity of Birmingham has been displayed in finding means to give a golden surface at a small price. No other artisans can make a given weight of gold go so far in gilding trinkets as those of Birmingham; and it thus arises that cheapness of price has nowhere else reached to such an extraordinary extent. "All is not gold that glitters," may be said of gilt jewellery generally; but it must in fairness be said, that the *surface* of these articles is really gold, for however thin the film may be, yet in the cheapest work it is continuous and unbroken, differing from the coating given to better work only in the degree of thinness—except indeed that some of the gold may be more or less "fine" than others. The substance of which the trinket is made may be copper or brass, or one of the numerous modern varieties of "white metal;" but all alike are susceptible of receiving a superficial coating of gold. The method of gilding is generally analogous to that which we shall presently speak of in respect of buttons; but the electro-process, described in our last Supplement, is becoming extensively applied to this purpose.

Buttons.

Buttons are among the most remarkable manufactures of Birmingham, and one of the few which are conducted on what may fittingly be termed the factory-system, since there are establishments in which some hundreds of persons (five or six hundred in one instance) are employed in one building, all making buttons. It is indeed surprising to see the extent to which so trifling an article influences manufactures, when once it has become a ruling item of fashion. When 'florentine' or 'silk' buttons, some few years ago, began to lessen the use of gilt buttons, the trade suffered somewhat of a shock; but things have adjusted themselves to the taste of the day, and the button-makers are now among the best-employed artisans of the town. Half a century ago Hutton spoke of the button-trade at Birmingham in the following quaint terms:—"This beautiful ornament appears with infinite variation; and though the original date is rather uncertain, yet we well remember the long coats of our grandfathers covered with half a gross of high-tops, and the cloaks of our grandmothers ornamented with a horn button nearly the size of a crown-piece, a watch, or John-apple, curiously wrought, as having passed through the Birmingham press. Though the common round button keeps in with the steady pace of the day, yet we sometimes see the oval, the square, the pea, and the pyramid flash into existence. In some branches of traffic the wearer calls loudly for new fashions; but in this the fashions tread upon each other and crowd upon the wearer. The consumption of this article is astonishing, and the value from threepence a gross to one hundred and forty guineas. There seem to be hidden treasures couched within this magic circle, known only to a few, who extract prodigious fortunes out of this useful toy, whilst a far greater number submit to the statute of bankruptcy. Trade is like a restive horse—can rarely be managed; for where one is carried to the end of a successful journey, many are thrown off by the way." Buttons, it must be owned, are not now such splendid affairs as they were in Hutton's time, but the trade has probably vastly increased in extent.

The materials of which buttons are made are very various, and this variety gives rise to a subdivision somewhat akin to that which we have already noticed, although not so marked. Besides the well-known gilt buttons, plain and figured, there are plated, silk,

florentine, and other covered buttons, pearl, horn, shell, bone, wood, glass, and porcelain buttons, and probably many others. The two latter-named varieties are made at the works where either glass or porcelain articles are manufactured; but the rest are produced chiefly at Birmingham, the different manufacturers producing their respective varieties.

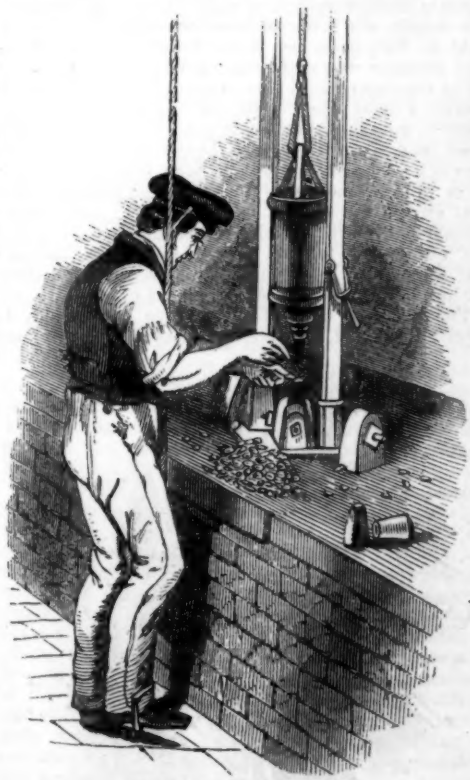
The establishments of Mr. Elliott and of Messrs. Hammond and Turner, two of those in which buttons are made to a vast amount, are among the most interesting in Birmingham. The former of these factories consists of a number of distinct buildings encompassing an open area or court, and each devoted to a particular kind of button-making, or a particular department of the general manufacture. The number of females to which the process gives employment is very large, and the nimbleness with which most of the processes are carried on by them is truly remarkable.

We may first select a common gilt button, and follow it through its processes of manufacture. The material of which these are made is sheet copper, or a mixed metal of which copper is a component part. From these sheets, "blanks" or circular pieces are cut out, a trifling degree larger than the intended size of the button. This is done by means of small presses, of which there is a very large number in various rooms of the factory, devoted to one or other of the different kinds of button. The press for cutting the "blanks" has a circular cutter or punch, worked by a lever or handle; and a female holding a sheet of metal in one hand and the lever of the press in the other, cuts the blanks with surprising rapidity, shifting the copper after each cut in order to expose a new part of the surface, and causing the punch to descend after each adjustment.

Whatever be the form or nature of the button, this preliminary punching of the blank is almost always observed; but beyond this, many varieties occur. The common flat gilt buttons for coats are flat on both sides, and consist of but one thickness of metal, which is punched out in the form of a blank. But there are many kinds of livery buttons, small globular buttons for boys' dresses, and other kinds, which are convex on the outer surface; and this convexity has to be given to them after the blank is cut. Again, of those which are convex, some are of one thickness only, presenting at the back the concave side of the same piece of metal which is convex in front; while others (called "shell" buttons) are hollow, and made of two pieces of metal, one for the front and the other for the back. In this latter case, there are two blanks or circular pieces punched out separately, one called the "shell" and the other the "bottom." The shell, as well as convex buttons generally, is pressed to a convex shape by a machine similar in principle to the punching-press, but having a curved polished surface to act upon the metal, instead of a punch. In this occupation, again, the celerity with which the workwomen stamp each of the little bits of copper consecutively is perfectly wonderful, twelve gross being frequently thus stamped in an hour by one female, or nearly thirty per minute! As each little blank, when made convex, remains in the die, the removal of it by the fingers would consume longer time than the actual stamping; and the workwoman therefore adopts a dextrous mode of jerking out the finished piece in the very act of placing a new one, in the same way that a banker's clerk does when weighing "light sovereigns," but with far more tact and quickness. When it is considered that each little piece of metal is put into the die separately, stamped by a press moved with the hand, and removed from the die before another is placed, and that all this is repeated thirty times in a minute, the celerity with which the hand and fingers must move may be appreciated.

The blanks, as they come from the punching-press, have a kind of rawness of edge, which requires to be smoothed to fit them for their after appearance. This is done by turning each one slightly in a lathe to give regularity of surface. In order to bring the two parts of a "shell" button together, they are exposed to the action of a die and punch so peculiarly adjusted, that the edge of the "shell" becomes bent over and lapped down upon the "bottom," securing the two together in a way at once firm and neat, without the employment of any solder, rivet, or other mode of fastening.

The body of the button, thus formed by any of these means, is frequently decorated on the surface with a device, such as the crest on a livery button, the device on a naval or military button, the few words which are generally stamped on the back of a button, &c. These are always produced after the general form is given to the button, and the dies necessary for this purpose comprise an important part of the stock of the manufacturer. These dies are made of steel, and have engraved on their surfaces the exact reverse of the device to be given. There is in almost all such cases a double pattern, one on the lower die, on which the button is placed, and one on the upper die, or "force," which descends to give a powerful blow to the button. The presses used by the females, for punching and shaping the blanks of the buttons, have not power enough to stamp these devices; and the workmen therefore use a kind of stamping-press such as is here



[Stamping-Press for Buttons.]

shown. The man places the button on the lower die, raises a heavy weight to the lower part of which the upper die is attached, and allows it to fall with great force, by which the button becomes indented with the device engraved on the die.

These processes of punching, pressing, and stamping are variously modified according to the kind of button about to be produced. For instance, a common brace-button has, as is well known, four small holes instead of a shank. The blank is first cut out; then the concavity is given to it by a separate punch or press, and the four holes are pierced by a sharp-pointed punch; and these holes are afterwards "countersunk," or rendered smooth at the edges to prevent cutting the thread, by applying each hole separately to a steel piercer.

The *shank* of a button is in some respects more remarkable even than the blank, partly on account of its manufacturing arrangements—strange as they will appear to most persons. It might well be supposed that in large factories where five or six hundred persons are employed in making buttons, the production of the bit of twisted wire which forms the shank would at least form one of the departments. Yet this is not the case: the button-makers are not shank-makers; the latter branch being carried on by a wholly distinct class of manufacturers, of whom there are three or four in Birmingham. The reason seems to be, that the machinery employed is so costly and intricate, and the value of each shank when made so extremely minute, that nothing less than making for a great many button-makers could pay for the maintenance of a regular establishment; so that the button-makers, as a body, can buy the shanks cheaper than make them.—Thus does the commerce of manufactures adjust and regulate itself when left to seek its natural channels. The shanks are made of brass wire, and vary from eight to forty gross per pound weight. In the beautiful machine now employed for their manufacture, a coil of wire is so placed that one end gradually advances towards a point where a pair of shears cuts off a short piece; a stud then presses against the middle of the piece, and forces it between the two jaws of a kind of vice in a staple-like form; the jaws then compress it so as to form the eye of the shank; a little hammer next strikes the end to make it level; and lastly, another movement enables the shank to drop into a box quite ready for use. It was said a few years ago that three firms in Birmingham make between them six hundred millions of button-shanks every year.

The blank or body of the buttons being ready to receive the shank, they are handed over to workwomen

[Soldering Button-Shanks.]

seated at small benches, who proceed to attach a shank to each button with astonishing rapidity. The button is placed down flat, with its back uppermost; the woman takes up a shank, and places it in the proper position on the button; she at the same time takes up a little piece of bent iron, capable of acting as a spring clasp, and clasps the shank tightly to the button; she next touches the foot of the shank, at the junction with the button, with a little solder; and when many dozens or hundreds are thus adjusted, the whole are placed upon an iron plate, and exposed in an oven to a heat sufficient to melt the solder and unite the shank firmly to the button. This clasping of the shank to the button, singly and by hand, is one of the many processes in button-making partaking almost of the marvellous, for the celerity with which it is accomplished.

We have not professed to follow the exact order in which the processes are conducted, because this order varies somewhat according to the nature and quality of the button; but we have indicated most of those which actually take place, up to the time when the gilding or silvering is to be effected.

Many kinds of brace-buttons, livery buttons, and soldiers' buttons, have a silvery white appearance, which is imparted to them in a simple but efficient manner. The buttons, after being thoroughly cleansed in an acid solution, are put into an earthen pan containing a dry or nearly dry mixture of silver, common salt, cream of tartar, and one or two other ingredients. The buttons are well worked up with this mixture by means of a brush, and in the course of a minute or two the whole of them are coated with a clear and equable surface of silver.

The gilding is a more elaborate process. The gilt buttons are, in the odd but concise language of the workmen, called "all-overs" or "tops," according as they are gilt all over, or only on the outer, exposed surface. There is also a distinction between the "yellow" and the "orange" gilding, the former being affected in colour by the previous use of a mixture called "similor" ("gold-resembling," as it seems to signify), made of zinc and mercury. We will therefore select an "orange all-over" and an "orange top" as examples of the processes adopted.

For the first of these the buttons, when properly cleaned, are put into an earthen pan, together with some "quick-water" and gold-amalgam, the chemical action of which on each other, and on the button, is very curious. The gold is neither a liquid nor a leaf, but is mixed up into a kind of paste with mercury: this paste, however, will not act upon the button unless a thin film of mercury be previously deposited on the surface; and to produce this deposition is the object of the "quick-water," or "gilders' aquafortis," which is a solution of nitrate of mercury. The buttons, the quick-water, and the amalgam are worked up together in the pan by means of a brush; a chemical (or perhaps galvanic) action takes place between the copper of the button and the mercury of the quick-water, whereby a thin film of mercury becomes precipitated on the button; and in this state the button is prepared to receive a second thin film of the amalgam.

For gilding the "tops," as the object is (for cheapness) to use gold only on the outer surfaces, the buttons are arranged side by side on boards having little holes to receive the shanks. Quick-water is brushed over the surfaces; and after this the amalgam paste is worked on them, to which it adheres only on the parts which have received the thin film of mercury from the quick-water.

In both these cases, then, we have the buttons coated with mercury and gold at their surfaces; and to get rid of this mercury is the object of the next process, one

which has always been deemed very deleterious, but which is now conducted on a better plan than formerly. The buttons are put into the "gilding-cage," an iron wire-gauze cylinder, nine or ten inches in diameter, provided with an iron door and a long handle. This is inserted in a cylindrical oven, so nearly closed

[Cage and Oven, for Button-Gilding.]

as only to allow the handle to protrude through the front. The heat within soon causes the mercury to evaporate from the surface, and a very careful arrangement of flues is adopted, to carry off these fumes to separate condensing-chambers, where the mercury resumes its metallic form. A woman sits in front of the oven, and keeps the cage of buttons constantly rotating, by means of a winch-handle, to allow all the buttons to be equally acted on by the heat.

There are about this time other subsidiary arrangements for cleansing the surface of the button, heightening the colour of the gold, &c.; but these we may pass over, and proceed to notice the "burnishing." This process is effected at small lathes, provided with simple apparatus for retaining each button temporarily while it revolves; and a workman, with a burnisher of hæmatite, or blood-stone, burnishes the surface of each button brilliantly in the course of a very few seconds.

Let us next say a few words about florentine and silk buttons, the manufacture of which occupies a large and important department of the factory. It would be worth a penny to buy a coat-button for the purpose of dissecting it piecemeal, were it only to see how complex and ingenious are its arrangements. We should there find (in most specimens) two circular bits of iron, a piece of thick pasteboard, a piece of thick canvas, and the outer silk or florentine covering. All these are cut out by stamping or punching presses, such as we before had to notice. The sheet of iron, of paper, of canvas, or of florentine, is shifted gradually till it is nearly all cut up into little discs; and these operations give to many of the shops the same bustling and busy appearance which our frontispiece represents, nearly all this department of the work being carried on by females.

[Burnishing Buttons.]

The mode in which all the pieces are fixed together is very remarkable. There is no glue or cement, no riveting, no sewing, plaiting, twisting, or other modes of fastening; all being adjusted and fixed simply by stamping or pressure. Within the outer cloth cover is an iron casing called the "shell," within this is a disc of paper, then a disc of cloth, and at the back of all a disc of iron having a hole in the centre, through which some of the canvas is forced as a means for sewing the button on to the coat or garment. All these are placed, in their proper order, in a kind of die or cell, and a descending punch, worked by a press, first fixes the cover to the shell, and then these two to the other three bits, curling up the edges of the two discs of iron in such a peculiar way as to enable them to clasp all the five bits firmly, and to hide all raggedness and imperfections of edge. The internal mechanism of the presses, to effect this, is beautiful and ingenious.

Some of the silk buttons have the iron "shell" blacked with japan before being used; some are convex, while others are flat; some have a woven device in the centre of each, obtained by having the silk or other material wove expressly for the purpose, and by having each little disc marked out carefully by a separate apparatus to ensure accurate punching; some have braided edges, produced by an additional number of pieces, and an additional complication of the stamping process; and indeed there are numerous modifications of the covered button which it would be difficult to particularize here; but the punching out of separate little discs, and the fixing of these by stamping or pressure, are the prevailing features of the manufacture among all.

White linen buttons, of a remarkably neat appearance, are among the novelties of recent times. They consist of a tin or white metal ring, over which a disc of linen is stretched like the parchment of a tambourine; and the beautiful manner in which the two are fixed together by a single action of the press is

very striking. The buttons made of bone, of horn, of wood, of mother-of-pearl, and of other materials, are generally the produce of other manufacturers, who work out their results by the aid of the circular saw, the lathe, the press, and a few other pieces of apparatus.

A finishing department of the factory is devoted to the papering and packing of the buttons, a matter in which almost as much neatness and dexterity are shown as in the making of the buttons themselves. The buttons are sewn on to cards or papers, by girls, with astonishing rapidity; and these cards are packed in pasteboard boxes made with much elegance.

We may finish these few details by remarking, as an example of the vast amount of capital, of skill, and of persevering ingenuity involved in the invention of an article apparently so insignificant as these, that we were shown at this factory a new button, scarcely yet introduced for sale, on which several thousand pounds have been expended, and many months' labour bestowed, before it could be brought to the desired perfection. It is a peculiar composite material, designed to combine the advantages of many others, such as hardness, lightness, strength, and a beautiful silkiness of appearance.

Brass and Bronze Work.

The manufactures in brass, in bronze, in ormolu, and in mixed metals which have an intermediate character between the cheapness of iron and the costliness of gold or silver, is carried on very extensively at Birmingham, chiefly for ornamental purposes. Gates and railings, vases and tripods, chandeliers, lamps, and pedestals, small busts and groups—these are among the subjects to which the manufacture relates.

Some readers probably think brass to be, like copper or tin, a simple metal; but it is not so; it is a mixture of copper and zinc, pretty nearly in the proportion of two of the former to one of the latter. A gold-coloured alloy called "Prince Rupert's metal" consists of about equal weights of copper and of zinc. Bronze, for various purposes of casting, consists essentially of copper and tin, to which a little zinc or lead, or both, are sometimes added; but in every case the copper amounts to eight or nine tenths of the entire weight. For various ornamental purposes, other mixtures of these ingredients are sometimes adopted; but as a general standard, it will suffice to say, that brass consists of copper and zinc, while bronze consists almost wholly of copper, variously but slightly modified by other metals. The mixed metal, of whatever kind it may be, is produced by melting together the component metals into an ingot or other convenient form.

The formation of manufactured articles from brass or bronze involves mechanical operations depending on the kind of article to be made. One very large and fine establishment in Birmingham is devoted to the manufacture of commodities in which brass tubing is principally employed, such as brass bedsteads, curtain rods, gas-fittings, telescope-tubing, and numerous other articles. Other manufacturers, on the contrary, devote their attention principally to such goods as require castings in brass or bronze.

Brass tubing is made from sheet metal, by cutting up the sheet into oblong strips, and bending these round a central core, or mandril, whose thickness equals the intended internal diameter of the pipe. The two opposite edges of the brass are made to lap one over the other, and are in that state soldered together. When soldered, the tube is cleansed and brightened by means of dilute acid, and is then ready for 'drawing.' This drawing has for its object the imparting to the tube a cylindrical form which it could not perfectly attain by the process just described. A mandril or rod is passed through the tube, and the latter is drawn forcibly through a circular hole somewhat smaller than the external diameter of the tube, being at the same time pressed closely in every part to the mandril; by which action both the internal and external surface become regular, cylindrical, and smooth.

When once a rod or a tube of brass is made, the forms into which it may be brought are almost endless, by the turning-lathe, the file, the drill, and other mechanical agents; the operations in this respect differing but very little from those relating to other hard metals.

By far the most important manufactures in brass and bronze are, however, those which depend mainly on casting or founding. Messrs. Messenger's establishment at Birmingham is one of those which exemplify favourably this kind of manufacture. In the recent exposition of ornamental castings in London, having relation to the decoration of the new Houses of Parliament, some beautiful specimens, sent in by this firm, met with especial admiration from the chasteness of design and fineness of execution.

The kind of ornaments thus produced may be for purposes either of strength or elegance; for while on the one hand large gates or balustrades for buildings are often made in this way, so on the other are copies from statues and busts. The gates under the marble arch in front of Buckingham Palace are an example of the former, while specimens of the latter are familiar to most persons.

The arrangements for casting in brass or bronze are very similar to those preparatory to the silver-plate manufacture, noticed in our last Supplement. There must first be prepared a model, representing the form and size of the object to be produced; which model depends for its beauty on the taste of the draughtsman who prepared the original design. Sometimes the models are of clay, sometimes of wax, and in the instance of a magnificent set of gates and balustrades which we saw under process of manufacture at Messrs. Messenger's, the models of all the different parts were turned and carved in mahogany. These models or patterns are sometimes used at once to impress the moulds: but in other instances a permanent metal pattern is produced exactly like the original model, and from this pattern the articles are afterwards made.

The moulding or casting is effected in sand of a very peculiar quality, which has a reverse or cavity depressed in it by the pattern, such as to constitute an exact mould of the object. The brass, bronze, or mixed metal is brought to a liquid state in adjoining furnaces, and is poured into these sand moulds, where it solidifies on cooling. The casting is, in fact, exactly analogous to that exhibited in an iron-foundry, but with the important addition that a very much higher degree of care is required in every part of the operation, both in the fusion of the metal and in the preparation of the mould.

There are various ways of imparting to articles made of brass or of bronze an external beauty of finish which the metal in its original state would not present. Some articles of bronze have an artificial 'verde antique' or old green tint imparted to them, by a composition applied to the surface after casting. Some have a warmer or browner tint; while some are touched on the projecting parts with a gold-coloured powder, which gives a peculiar metallic appearance; but this latter expedient is adopted chiefly where figures or ornaments of plaster are coloured to look like bronze.

Brass-work is brought to a brilliant yellow appearance by the process of lacquering, a process now conducted so skilfully that the lacquered article presents

a very close resemblance to those which have been gilt. When any of the countless articles of brass which Birmingham produces has been formed, by casting, drawing, stamping, chasing, or other mechanical operations, they are cleansed from grease by being heated, then laid to steep or 'pickle' in dilute acid, and brushed well with a wire or other hard brush. Each article is then dipped separately into aquafortis, by which means it speedily acquires a clear bright yellow colour, wholly free from specks and stains: indeed it is the remarkably neat and clear-coloured appearance of the small brass goods which has given Birmingham so much celebrity for them. The cleansed and brightened article is then washed in water, dried in hot sawdust, and then burnished on some or all parts of its surface, according to the pattern and object. The burnishers are made of blood-stone, such as is used for burnishing buttons, and the mode of proceeding is exactly analogous to other metal-burnishing, the article being held in the hand, or down upon a bench, or in a lathe, according to its shape and size.

The brightened and burnished article of brass receives finally a depth and richness of tint by the process of lacquering. Lacquer is a liquid composed of spirit of wine, gum-lac, turmeric, saffron, and one or two other ingredients. The brass-work is made clean and hot, and is in that state coated with a layer of the lacquer, either by dipping or brushing. A subsequent drying finishes the process.

It will be very readily conceived that bronze statues, bells, cannon, lamps and candelabra, ornamental railings, handles, rosettes and scrolls, and the countless other articles made of brass or of bronze, however different they may be as works of high art, are all produced by modifications, more or less marked, of the processes which we have here indicated; and these few may therefore be taken as types of all the rest.

Guns.

The manufacture of muskets is one of the most important branches of Birmingham industry, and one which illustrates as well as almost any other the subdivision to which employments in that town have been subjected. Fowling-pieces, being much less extensively employed, and commanding a higher price, are made to a considerable extent in the metropolis; but the infantry muskets, which are counted by tens of thousands at a time, owe their production in this country almost exclusively to Birmingham. A few years ago, the French government had a hundred and forty thousand muskets made here in seven months; and during the last war it was estimated that Birmingham produced at the rate of a musket per minute throughout the year.

There is no such trade as a gun-maker, properly so called, in Birmingham; or, at least, there is no gun-factory; all the establishments, however large they may be, being devoted to the production of parts only of a gun. The same gun travels about from factory to factory, from shop to shop, before it assumes its finished form; and the only person who could consistently be called a gun-maker is he who has the gun finished by putting the several pieces together.

The first and most important part of a musket is the barrel, and the manufacture of this involves larger arrangements than any other part. These barrels are of two kinds, plain and twisted, the latter being the best and the most expensive. For the plain barrels very tough and good iron is brought to the form of a thick sheet, and is cut to a long strip sufficient for one barrel. This strip, called a 'skelp,' is heated at the thicker end in a fire, placed upon a hollow cavity in an anvil, and hammered so as to turn up the two edges, thereby giving to it a concave form. A mandril is inserted in this cavity, and the hammerman dexterously beats up the iron round this mandril, so as to form it into a tube. The mandril is withdrawn, the iron is again heated to a welding temperature, and hammered until the two meeting edges become united firmly. The whole length of the skelp is gradually and successively treated in the same way.

A twisted barrel is brought to the tubular form in a very curious way. The iron is cut or rolled to the form of very long narrow strips; and one end of a strip being fastened to a rotating mandril or rod, the whole is turned round the mandril in a spiral form, exactly like a spiral spring, or like the worm of a still. This spiral is taken off the mandril, heated, and hammered in such a way that all the edges weld and close together, forming a continuous tube from end to end.

But although a tube is produced by either of these means, it is very coarse and rough both within and without; and to impart the necessary evenness and regularity is now an important matter. The barrel is brought straight by a few blows on an anvil; and is next bored internally by a boring-mill, an instrument so adjusted that the interior of the barrel is scooped or scraped from end to end, until it is perfectly cylindrical and smooth. The exterior is then ground by means of very large rough grindstones, to the surface of which the barrel is applied; in some instance it is turned by cutting tools as in other kind of turning.

After one or two further processes, the barrel is sent to the 'proof-house,' a remarkable feature in the Birmingham arrangements. During the war, a charter or act was granted by which the Birmingham gun-makers were empowered to establish a proof-house, governed by a warden and other officers. This proof-house was to afford the means for testing the strength of the musket-barrels made at Birmingham; in order, on the one hand, that the government might ensure the efficiency of the barrels, and, on the other, that the reputation of the Birmingham manufacturers might not suffer from any of their number selling ill-made barrels. Every maker is bound under a heavy penalty to send every barrel he may make to be tested at the proof-house; and he pays a few pence per barrel as a means of maintaining the expenses of the establishment. The gun-makers themselves are the chief officers of the establishment, elected from time to time, so that a very close connexion exists among all the fraternity.

The proof-house is a large building in the south-east part of Birmingham. In one of the buildings men are employed in receiving the barrels as sent in from the different manufacturers, and loading them, the charge being four or five times as great as the musket will have to carry in actual use. The barrels, as loaded, are handed over to other men, who range them side by side on a low stage in a different building. This building, a dismal-looking place, has a range of open windows or hinged doors on one side, and a large heap of sand on the other, the muzzles of the barrels being directed towards the sand. The barrels are so arranged that the touch-holes shall rest upon a little trough filled with a train of gunpowder; and when about a hundred barrels are so ranged side by side, the men come out of the building, close the doors and openings, and set light to the train, which is brought through to the outside for this purpose. The whole number are fired off at once, producing a deafening report; the contents of the barrels are fired into the heap of sand opposite, and are thus prevented from doing mischief. The doors are then opened, the barrels are removed and examined one by one; and if any have yielded to the explosive force, a man marks with chalk the defective spot, to indicate to the barrel-maker where he must reforge his work. The workmen, who are paid

by the piece, are required to mend the defects in their own work free of extra payment.

The barrels, after proving, are cleaned and finished, and provided with numerous little appendages contingent on their after use. The 'stocker' next takes his part of the routine. He makes the stock or woodwork, generally of walnut-wood, which is cut to the required form by saws, planes, chisels, spoke-shaves, and other tools. The channel to receive the barrel, the cavity for the lock, and all the other peculiarities of shape, are cut out, and the barrel is fixed into the stock by screws and other fastenings. The bronzing of the barrels (which is sometimes done to save the soldier from the fatiguing duty of cleaning it), the staining and polishing of the stock, the insertion of ornamental pieces of brass or any other appendage of a decorative kind, and many minor processes, occupy a considerable number of persons, who work entirely distinct from each other, not only as respects the individual workmen, but also in respect to the factories and workshops; for the 'stocker' and the 'putter-together' and the 'finisher' all ply their respective avocations at their own shops, away from the master-manufacturer, who takes the general designation of 'gun-maker.'

It may appear rather singular that the locks for the muskets are made almost wholly at or near Wolverhampton; but this is only another exemplication of the subdivision-principle, those artisans being able to make their wares best and cheapest who devote their whole attention to the matter. Gun-locks being made of small pieces of iron and steel, their manufacture depends on the use of the hammer, the file, and such like working implements; and indeed their manufacture resolves itself into a finer kind of smiths'-work. The mode of firing off a gun has had a good deal of influence on the construction of the lock. In former times the soldier fired his match-lock or arquebuss by means of a fire-match, and in that state the weapon could hardly be said to have had any lock at all. After that (and indeed until very recent times) the lock afforded very ingenious means for striking a light by means of flint and steel, and directing the spark into the touch-hole. But now, the use of percussion or detonating caps has considerably altered the formation of the lock. These caps are tiny boxes or cells of copper, not so large as a pea, containing a morsel of fulminating mercury, or chlorate of potash, or some other detonating compound. One of these caps is so placed on the lock that a blow causes the mixture to explode, and ignite the powder through the touch-hole.

There is one very curious arrangement sometimes adopted in guns, called *rifling*, or making rifle-barrels, the object of which may be thus explained:—If a bullet be rammed down into a barrel, and the gun fired off, the bullet will be projected straight forward, provided it passes equably through the barrel; but if, as is sometimes the case, it rubs more against one side of the barrel than the other, it will be diverted from its right course, and curve round while passing through the air; so that the marksman misses his aim. To rectify this, the barrels of rifles are grooved spirally on the inside, in order that the bullet, by winding along these grooves in its progress, may acquire a rotatory motion round its own axis, which afterwards prevents it from swerving either to one side or to the other. This rifling is effected by a spiral-cutting instrument, fixed on the end of a rod, to which a peculiar movement is given. The number of grooves in this spiral, the number of turns which each groove makes in its course through the barrel, and the depth of the grooves, are all points determined on differently, according to the opinions of practical men; but the principle is the same in all, viz., that if the bullet can be made to spin round or rotate on its axis while passing through the barrel, it will continue to worm its way through the air with more straightness of path than otherwise will be attained.

It may in conclusion be remarked, that the musket (or rather, the rifle) is the most advanced form of hand-guns, the variety of which in former times was much greater than is generally supposed. The annexed cut will give some idea of the extreme simplicity of some of the contrivances formerly used: it

is taken from a MS. dated about 1468, and exhibits a soldier applying a match to what is in fact nothing more than a small cannon fixed to the end of a handle. As improvements became gradually introduced, so were new names applied; and thus we find various kinds of hand-guns called arquebusses, haquebuts, calivers, carabines, fusils, musketoons, petronels, fire-locks, and many others. The musket itself is said to have been a Spanish invention, and to have made its first appearance at the battle of Pavia, where it contributed in an especial manner to decide the fortune of the day.